

F=ma Past Paper Questions

Jan 2002 to Jan 2009

- 8 (a) A cricketer throws a ball vertically upwards so that the ball leaves his hands at a speed of 25 m s^{-1} . If air resistance can be neglected, calculate

Q8 Jan 2002

- (i) the maximum height reached by the ball,

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- (ii) the time taken to reach maximum height,

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- (iii) the speed of the ball when it is at 50% of the maximum height.

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(4 marks)

- (b) When catching the ball, the cricketer moves his hands for a short distance in the direction of travel of the ball as it makes contact with his hands. Explain why this technique results in less force being exerted on the cricketer's hands.

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(2 marks)

- 5 A car accelerates at a steady rate of 2.5 m s^{-2} along a straight, level road. The mass of the car is $1.3 \times 10^3 \text{ kg}$.

Q5 Jun 2002

- (a) Calculate the magnitude of the resultant force acting on the car.

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(2 marks)

- (b) When the accelerating car reaches a speed of 2.2 m s^{-1} , the total force opposing the motion of the car is 410 N.

Calculate

- (i) the driving force provided by the wheels,

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- (ii) the power delivered to the wheels of the car.

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(3 marks)

- (c) Explain how the total force opposing the motion of the car is affected when it is travelling up a hill.

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(1 mark)

- 3 A girl kicks a ball along the ground at a wall 2.0 m away. The ball strikes the wall normally at a velocity of 8.0 m s^{-1} and rebounds in the opposite direction with an initial velocity of 6.0 m s^{-1} . The girl, who has not moved, stops the ball a short time later.

Q3 Jan 2003

- (a) Explain why the final displacement of the ball is not 4.0 m.

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(1 mark)

- (b) Explain why the average velocity of the ball is different from its average speed.

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(2 marks)

- (c) The ball has a mass of 0.45 kg and is in contact with the wall for 0.10 s. For the period of time the ball is in contact with the wall,

- (i) calculate the average acceleration of the ball.

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- (ii) calculate the average force acting on the ball.

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- (iii) state the direction of the average force acting on the ball.

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(5 marks)

2 A constant resultant horizontal force of $1.8 \times 10^3 \text{ N}$ acts on a car of mass 900 kg, initially at rest on a level road.

Q2 Jan 2004

(a) Calculate

(i) the acceleration of the car,

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(ii) the speed of the car after 8.0 s,

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(iii) the momentum of the car after 8.0 s,

NOTE Momentum is no longer part of Y12

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(iv) the distance travelled by the car in the first 8.0 s of its motion,

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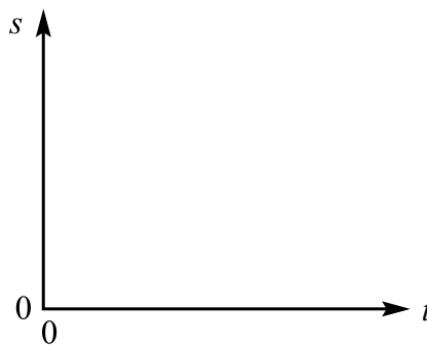
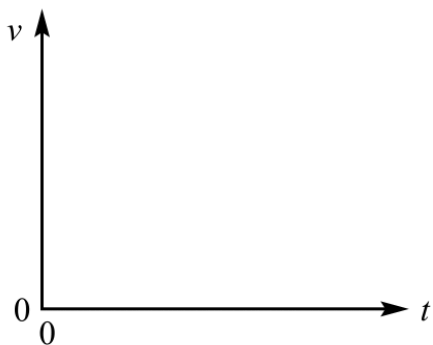
(v) the work done by the resultant horizontal force during the first 8.0 s.

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(9 marks)

Continued.....

- (b) On the axes below sketch the graphs for speed, v , and distance travelled, s , against time, t , for the first 8.0 s of the car's motion.



(2 marks)

- (c) In practice the resultant force on the car changes with time. Air resistance is one factor that affects the resultant force acting on the vehicle.
You may be awarded marks for the quality of written communication in your answer.

- (i) Suggest, with a reason, how the resultant force on the car changes as its speed increases.

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- (ii) Explain, using Newton's laws of motion, why the vehicle has a maximum speed.

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(5 marks)

2 (a) State the difference between vector and scalar quantities. **Q2 Jan 2005**

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(1 mark)

(b) State **one** example of a vector quantity (other than force) and **one** example of a scalar quantity.

vector quantity

scalar quantity

(2 marks)

(c) A 12.0 N force and a 8.0 N force act on a body of mass 6.5 kg at the same time.
For this body, calculate

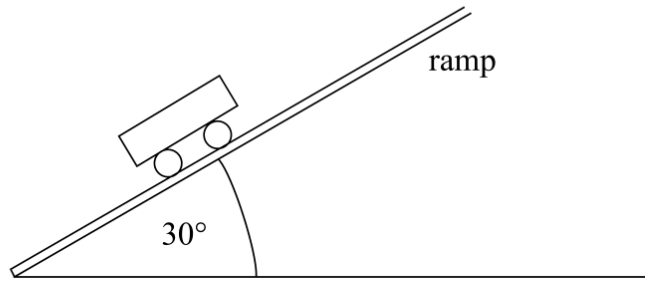
(i) the maximum resultant acceleration that it could experience,

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(ii) the minimum resultant acceleration that it could experience.

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(4 marks)

- 6 A fairground ride ends with the car moving up a ramp at a slope of 30° to the horizontal as shown in **Figure 3**.



Q6 Jun 2005

Figure 3

- (a) The car and its passengers have a total weight of $7.2 \times 10^3 \text{ N}$. Show that the component of the weight parallel to the ramp is $3.6 \times 10^3 \text{ N}$.

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(1 mark)

- (b) Calculate the deceleration of the car assuming the only force causing the car to decelerate is that calculated in part (a).

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(2 marks)

- (c) The car enters at the bottom of the ramp at 18 m s^{-1} . Calculate the minimum length of the ramp for the car to stop before it reaches the end. The length of the car should be neglected.

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(2 marks)

- (d) Explain why the stopping distance is, in practice, shorter than the value calculated in part (c).

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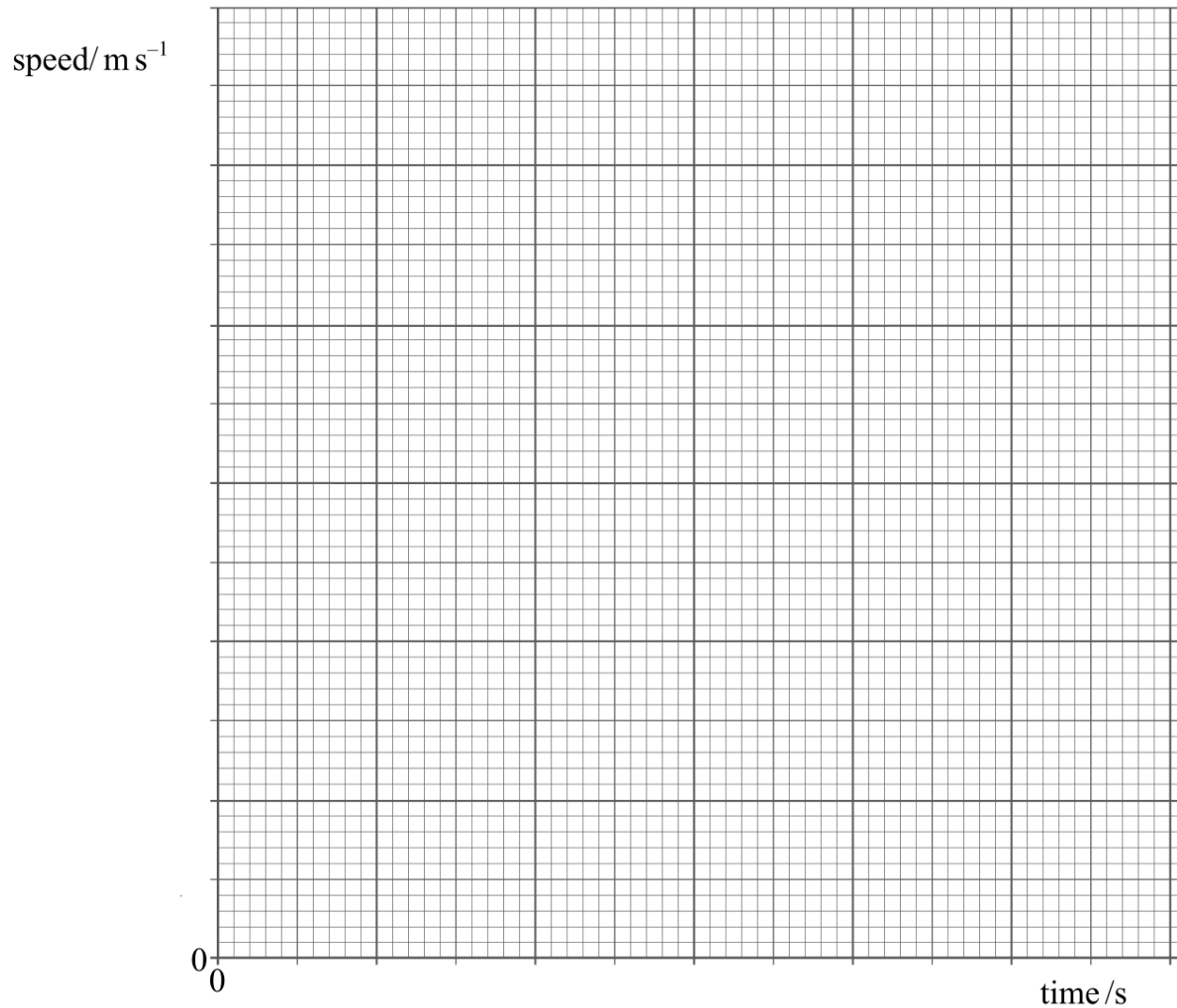
(2 marks)

- 1 A car accelerates from rest to a speed of 26 m s^{-1} . The table shows how the speed of the car varies over the first 30 seconds of motion.

Q1 Jan 2006

| | | | | | | | |
|--|---|------|------|------|------|------|------|
| time/s | 0 | 5.0 | 10.0 | 15.0 | 20.0 | 25.0 | 30.0 |
| speed/ m s^{-1} | 0 | 16.5 | 22.5 | 24.5 | 25.5 | 26.0 | 26.0 |

- (a) Draw a graph of speed against time on the grid provided.



(3 marks)

Continued.....

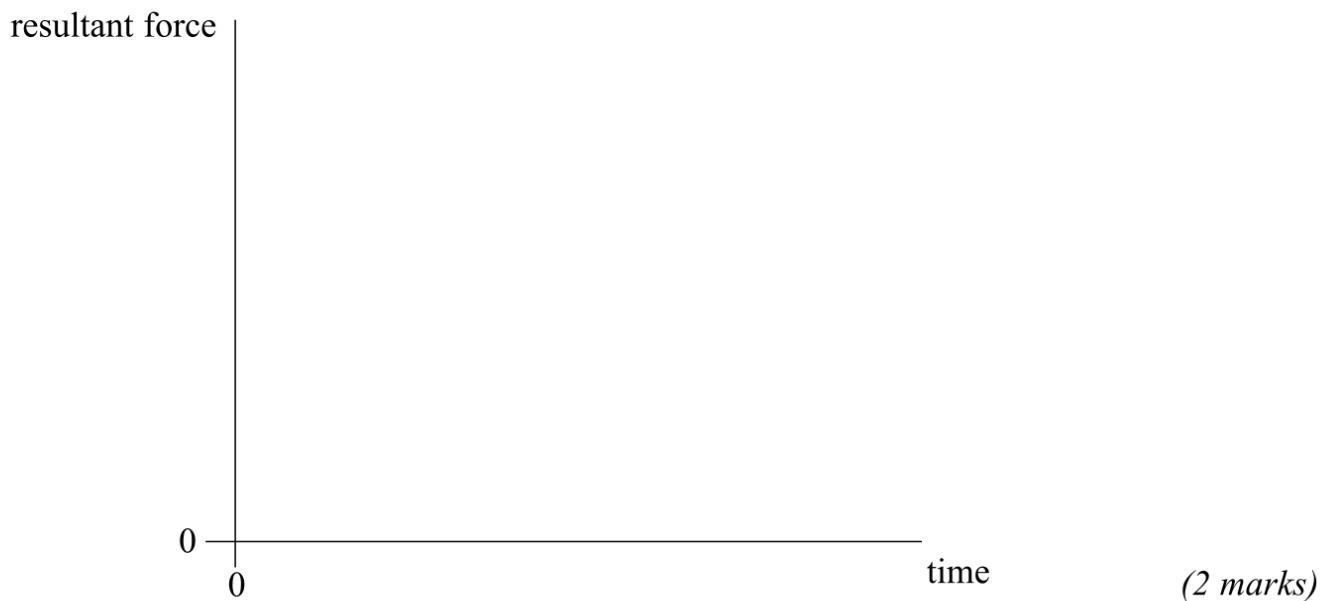
(b) Calculate the average acceleration of the car over the first 25 s.

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(2 marks)

(c) Use your graph to estimate the distance travelled by the car in the first 25 s.

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(2 marks)

(d) Using the axes below, sketch a graph to show how the resultant force acting on the car varies over the first 30 s of motion.



(e) Explain the shape of the graph you have sketched in part (d), with reference to the graph you plotted in part (a).

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(2 marks)

- 6 A supertanker of mass 4.0×10^8 kg, cruising at an initial speed of 4.5 m s^{-1} , takes one hour to come to rest.

Q6 Jun 2006

- (a) Assuming that the force slowing the tanker down is constant, calculate

- (i) the deceleration of the tanker,

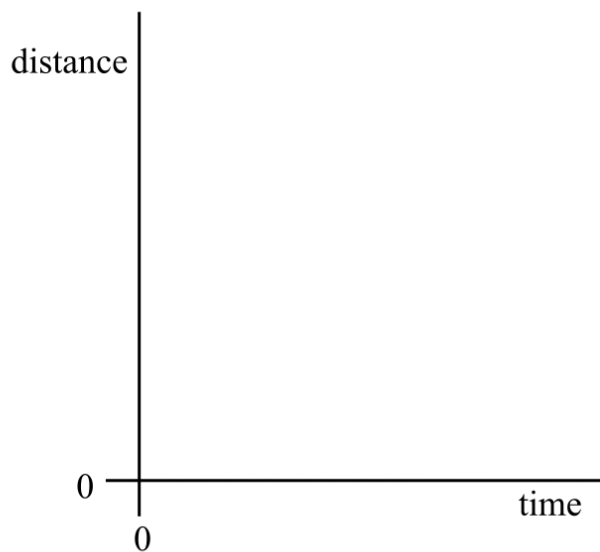
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- (ii) the distance travelled by the tanker while slowing to a stop.

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(4 marks)

- (b) Sketch, using the axes below, a distance-time graph representing the motion of the tanker until it stops.



(2 marks)

- (c) Explain the shape of the graph you have sketched in part (b).

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(2 marks)

5 An aircraft accelerates horizontally from rest and takes off when its speed is 82 m s^{-1} . The mass of the aircraft is $5.6 \times 10^4 \text{ kg}$ and its engines provide a constant thrust of $1.9 \times 10^5 \text{ N}$.

Q5 Jan 2008

(a) Calculate

(i) the initial acceleration of the aircraft,

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(ii) the minimum length of runway required, assuming the acceleration is constant.

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(3 marks)

(b) In practice, the acceleration is unlikely to be constant. State a reason for this and explain what effect this will have on the minimum length of runway required.

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(2 marks)

(c) After taking off, the aircraft climbs at an angle of 22° to the ground. The thrust from the engines remains at $1.9 \times 10^5 \text{ N}$. Calculate

(i) the horizontal component of the thrust,

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(ii) the vertical component of the thrust.

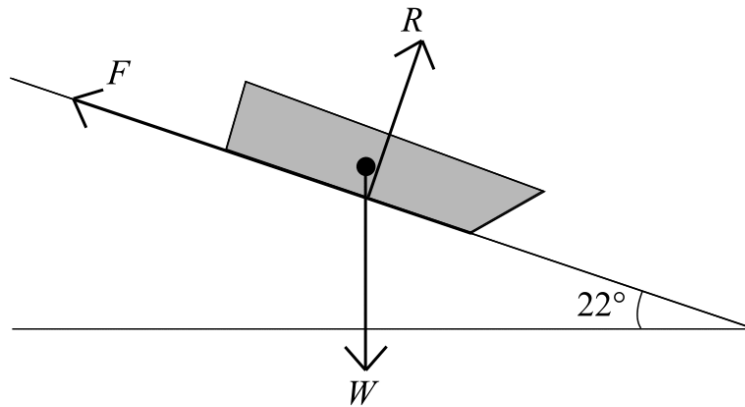
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(2 marks)

- 2 **Figure 2** shows a sledge moving down a slope at constant velocity.
The angle of the slope is 22° .

Q2 Jun 2008

Figure 2



The three forces acting on the sledge are weight, W , friction, F , and the normal reaction force, R , of the ground on the sledge.

- 2 (a) With reference to an appropriate law of motion, explain why the sledge is moving at constant velocity.

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(2 marks)

- 2 (b) The mass of the sledge is 4.5 kg. Calculate the component of W ,

- 2 (b) (i) parallel to the slope,

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2 (b) (ii) perpendicular to the slope,

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(2 marks)

2 (c) State the values of F and R .

F

R

(2 marks)